(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 777 103 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.06.1997 Bulletin 1997/23

(51) Int Cl.6: **G01B 5/24**, G01B 5/255

(21) Application number: **96850205.4**

(22) Date of filing: **03.12.1996**

(84) Designated Contracting States:
DE FR GB

(30) Priority: **06.12.1995 SE 9504360**

(71) Applicant: **Hörvallius, Torgny**
806 41 Gävle (SE)

(72) Inventor: **Hörvallius, Torgny**
806 41 Gävle (SE)

(74) Representative: **Benson, Anders**
The BAAS Bureau
Riddargatan 17
114 57 Stockholm (SE)

(54) **Method and means for measuring the wheel inclination or "camber" of a motor vehicle**

(57) The invention relates to a method for measuring the wheel inclination or "camber" of a vehicle. In a wheel assembly, e.g. in the front axle and suspension assembly of the vehicle, the wheel planes are somewhat inclined in relation to a plane perpendicular to the floor or base, the inclination representing the so called camber angle. According to the invention a simple method is proposed for determining the magnitude of the angle, independet of specific operating sites and sophisticated instruments. In a manner known per se a wheel subject to camber measurement is provided with an axial extension in the form of a pin (10) exactly coaxial with the wheel. The center line (x-x) of said pin will thus incline in relation to the floor by an angle = the camber angle. On the floor, directly in front of the set of wheels, a rod (15) or a like straight member is placed. An instrument (20) provided with two mutually perpendicular levels is placed on the rod. The instrument has a bridge pivotable about an axis (y-y) perpendicular to the center line (H-H) of the bar, said bridge, in a first step, being set with its pivot axis (y-y) truly horizontal and, in a second step, being pivoted so that its own plane becomes truly horizontal. The instrument is moved to the wheel pin (10) and the procedure is repeated. The change of inclination which the bridge is subjected to in step 2 represents the camber angle.

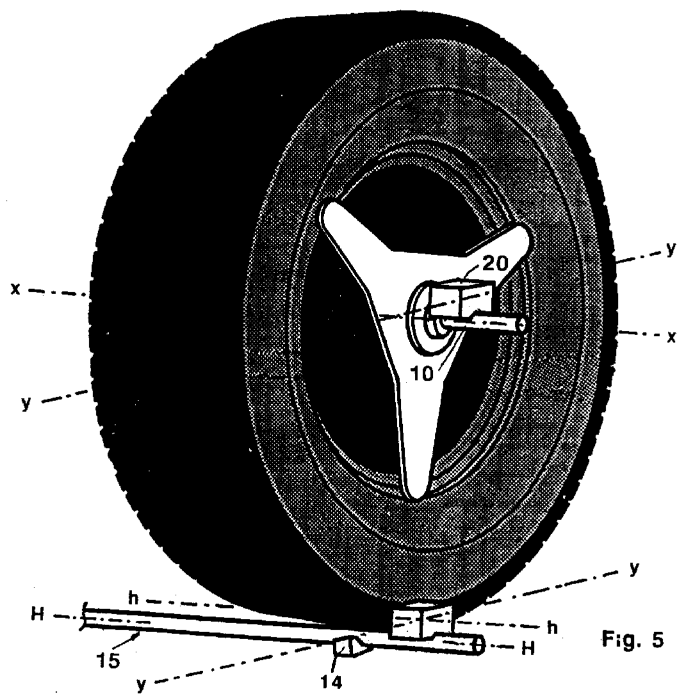


Fig. 5

EP 0 777 103 A2

Description

The adjustment of the wheels and wheel axles of a motor vehicle is an intricate but important question, as the driving characteristics of the vehicle will depend greatly on how wheels and axles are aligned and adjusted. When driving straight ahead the rotational planes of the front wheels are inclined in various ways in relationship to a vertical plane, more particularly to a plane parallell with the vertical symmetrical plane of the vehicle. Viewed directly from above the wheels show "toe-in" or "toe-out", that is to say they are set at a slightly oblique angle to the direction of travel, whereas, when viewed directly from the front they tilt somewhat, preferably outwards, in relation to said vertical plane, by an angle designated as the wheel inclination or "camber". How the steering pivot pins or "king pins" of the front wheels are inclined in various vertical planes also have influence on the driving, and for a more detailed description of the wheel alignment angles in the front axle and suspension assembly of a motor vehicle reference is had to US Patent No. 4 823 470, where these conditions are discussed at length. In this patent there are also disclosed methods for determining accurately the magnitude of the angles concerned.

The invention has for its object to make available a simplified procedure for measuring, while maintaining accuracy, the most important one of the wheel alingment angles, viz., the said wheel inclination or camber. The object is achieved through the procedure in accordance with the invention being applied in the manner defined in the characterzing clause of claim 1, whereas an arrangement for the implementation of the invention is described in the characterizing clause of claim 3.

In order to excercise the invention it is necessary that the direction of the axis of rotation of the wheels subjected to measurement be established accurately, and a very simple so called centering device for this purpose is disclosed in US Patent No. 4 011 659, to which reference is also had.

The invention will be described in the following with reference to the accompanying drawings, in which

- Fig. 1 is schematic front view of a wheel of a motor vehicle with the wheel inclination or camber angle indicated;
- Fig. 2 shows a wheel with said centering device mounted;
- Fig. 3 shows schematically how the camber is found between the pin of the centering device and a horizontal plane through the centers of the wheels;
- Fig. 4 illustrates a conventional V-block for use in excercising the invention, the block (a piece of square steel pipe) being shown in elevation and vertical section;
- Fig. 5 illustrates schematically the principle according to the invention of establishing the camber angle;
- Fig. 6 shows a plan view of a measuring instrument or "measuring prism" according to the invention, to be used when determining the camber angle:
- Fig. 7 is a front view of the prism of Fig. 6;
- Fig. 8 is a side view of the prism, whereas Fig. 8a shows an encircled portion of Fig. 8 on a larger scale;

Thus Fig. 1 shows a wheel of a vehicle as viewed directly from the front and resting upon a floor or base surface H. A plane perpendicular thereto is designated V, whereas a plane parallel to the wheel plane itself is designated D. The planes form an angle α with each other and, according to the foregoing definitions, the angle will thus represent the wheel inclination or camber. A line x-x represents the center line of the wheel and will thus extend perpendicularly to plane D. According to the simple geometrical relations the camber angle α is found between center line x-x and a line H-H parallel to the floor surface.

At this point of the desciption it seems appropriate to point out, with a certain emphasis, that when here and in the following "horizontal" or "vertical" planes or lines are discussed, <u>true</u> or <u>absolute</u> such planes or lines are not necessarily aimed at, that is to say, such planes which are perpendcular or parallel, respectively, to the direction of the gravitational force. The base or floor surface H according to Fig. 1 can be an ordinary workshop floor, and quite generally it can be said that it is "horizontal", but it is not very likely that it extends exactly perpendicular to the gravitational force; some small deviations do usually occur. As pointed out in the first mentioned patent this also means a complication in most conventional measurement systems for the wheel geometry of motor vehicles, as measurements require "levelled" planes or sites which are oriented exactly in relation to the direction of gravity.

According to the invention no such demands whatsoever on the premises are made and the camber measurements described here can be carried out on any flat floor. The gravity and its direction has a rôle to play, as will be described, but only within a measuring instrument designed according to the invention. When "true" or "absolute" horizontal or vertical planes or directions are aimed at in this specification it will be pointed out expressly.

In Fig. 2 there is shown a front wheel prepared for camber measurement and provided with a patented centering device 12 of the kind referred to above. The arrangement of this centering device means, in short, that a triangular support plate is clamped onto the outside of the rim of the wheel, and as disclosed in the patent a cylindrical pin 10 mounted on the plate can be brought, in a very simple manner, to assume a position exactly coaxial with the wheel, that is, the axis of the pin will coincide exactly with the rotational axis of the wheel.

A comparison with Fig. 1 thus shows that pin 10, with respect to its direction, coincides exactly with the center line x-x indicated in said Figure, a line which, indeed, also represents the rotational axis of the wheel.

In fig. 3 the starting position for establishing in accordance with the invention the camber angle α of a front wheel is illustrated diagrammatically. Two parallel wheels are shown, e.g. two front wheels. A rod 15 rests in a pair of V-blocks 14 (see Fig. 4) situated straight in front of and symmetrically in relation to the respective wheel. The V-blocks 14 are exactly alike and rest on a base which corresponds to the plane H of Fig. 1 and is represented by black triangles in Fig. 3.

It is assumed that the two wheels are mutually alike, that is to say, their centers are situated on the same level above the base upon which the V-blocks 14 rest. A deviation could be caused e.g. by the tires being differently worn, which can be compensated for by adjusting their air pressure. By measuring on either side, by means of a simple so called "height gauge", the height above the base surface of the lower edges of the wheel rims, it is possible to check that the rims and thus also the wheel centers are on the same elevational level on both sides.

By this assumption the "horizontal" line H-H (parallel with the base H) according to Fig. 1 will also strike the center of an opposite wheel and therefore the same line H-H is found in Fig. 3. According to the arrangement described rod 15 resting on the base in the front of the wheels will obtain the same direction H-H.

But in accordance with the foregoing a centering device 12 has been mounted on one of the wheels, and when its pin 10 has been set it will thus project perpendicularly to the rotational plane of the wheel. Thus the angle between the center line x-x of the pin and the horizontal line H-H through the wheel centers has to be the camber angle sought.

In Fig. 5 it is shown diagrammatically how this difference, representing the camber angle, between the inclination of pin 10 and that of rod 15 can be established with reference to a "true" horizontal plane according to the foregoing definition, without any such plane having to be created in reality. Instead, relative changes in relationship to such a plane is utilized by a gravity sensing instrument, shown in Fig. 5 as a prismatic body 20, called "measuring prism" in the following. This instrument can be placed on rod 15 as well as on pin 10 and by a magnetic lock, known per se, it can be temporarily locked onto said rod and pin, respectively.

The topside of prism 20 is shown in Fig. 6. The instrument will be disclosed in greater detail in the following, but from Fig. 6 it can be seen that it includes a bridge 25, which can pivot on journal pins about a pivot axis y-y. This axis extends perpendicularly to the supporting rod 15 or pin 10, and the pivot position of the bridge can be adjusted by means of a knob 35. Two levels 24 and 26 sensing the true horizontal position are located on the bridge 25 exactly perpendicular to one another. The first level 24 extends perpendicularly to the rod or pin, respectively, upon which the prism has been placed, whereas the second level 26 will thus extend in parallel with said members. Fig. 6 illustrates the position on rod 15 of the measuring prism in accordance with the prerequisites given.

In order to determine the camber angle α the measuring prism is first placed on rod 15. If it is turned about the rod it can obviously, by means of level 24, be set with its traverse direction represented by axis y-y truly horizontal. In this position the instrument is locked onto the rod by means of said magnetic locking device. The bridge 25, thus extending in the longitudinal direction of rod 15, can now as a whole be set in a truly horizontal position by it being turned about its axis y-y by means of knob 35, and the change in position can be observed on level 26.

The situation is now as follows, see fig. 5. Rod 15 rests in its V-blocks 14 on the base in front of the wheel, which rests on the same base. As this consists of an ordinary non-levelled workshop floor or the like, the direction H-H of rod 15 in relation to the true horizontal is unknown. However, as just described, the measuring prism 20 as a whole, bridge 25 included, has been set with its transverse direction, represented by axis y-y in Fig. 6, exactly horizontal, and this line reappears in Fig. 5. In the next step the movable bridge 25 of the measuring prism has been set exactly horizontal in its longitudinal direction as well, which is indicated by line h-h in Fig. 5.

Now, if the measuring prism 20 is removed from rod 15 and placed on pin 10 instead, see Fig. 5, in analogy with the foregoing it can first be rotated about pin 10 and locked after axis y-y has been brought to be truly horizontal. If now pin 10 were exactly parallel with rod 15, that is, the wheel were not inclined, level 26 should not indicate any change in relation to its position on rod 15. But if it is assumed that the wheel is mounted with a certain inclination, e.g. a few minutes outwards, pin 10 will point somewhat downwards, which means that level 26 on bridge 25 will deviate, and in order to restore its position bridge 25 must be rotated a small angle, and in accordance with the prerequisites given the restoring angle must be, indeed, the angle of camber α.

The bridge is rotated by means of knob 35, and as will be disclosed in the following the knob is so arranged and graduated that it indicates directly the restoring angle and thus the camber angle α.

Measuring prism 20 will now be described in greater detail with reference to, besides Fig. 6, also Figs. 7, 8 and 8a.

As shown in the last mentioned Figures measuring prism 20 has a U-shaped body 28, onto whose underside the said magnetic locking device, here designated 40, is secured. The locking device is provided in its underside with a V-groove 42, which extends exactly in the longitudinal direction of the U-shaped body 28. In order to offer more possibilities of orientation a further V-groove (not shown) perpendicular to groove 42 can be provided on the underside of the locking device. Locking on and off can be controlled by a handle 45.

As mentioned before the rotation of bridge 25 is operated by means of knob 35 which is arranged as shown in greater detail in Fig. 8. A screw spindle 30 secured in the body extends through an opening in bridge 25, which is urged upwards by a compression spring 34 inserted between the underside of the bridge and the bottom of U-shaped body 28. Knob 35 can be screwed up and down on screw spindle 30, and between the underside of the knob and the topside of bridge 25 a short angular piece 32 is inserted, which has a central opening through which spindle 30 extends. Furthermore, the angular piece 32 is placed with the ends of its shanks 33 in sliding contact with the underside of knob 35, said ends being smoothed off, whereas the corner edge 32' of the piece rests in a notch 25' crossing bridge 25, as shown in Fig. 8.

Now, notch 25' extends exactly perpendicularly to bridge 25 and thus parallel with the pivot axis y-y of the bridge, and the arrangement is such that the perpendicular distance between the pivot axis of bridge 25 and the centre axis of screw spindle 30 is equal to the distance between said pivot axis and notch 25' on the bridge. From a strict geometrical view these distances change somewhat in relation to one another when knob 35 is screwed up and down, causing bridge 25 to pivot, but the pivoting movement is small and in practice the distances differ insignificantly; they can be considered equal and are designated R. It is noted, see Fig. 8a, that angular piece 32 is allowed to tilt a little in notch 25' about its corner edge 32' during the adjustment movement, to further ensure that distance R be altered as little as possible.

Preferably screw spindle 30 consists of a standard internal hexagon head screw secured in the bottom of body 28 and having threads of pitch 1 mm. Furthermore, distance R is so adjusted that turning knob 30 one revolution in either direction, which thus means that the knob itself together with angular piece 32 and the bridge will move, at notch 25', up or down 1 mm, will cause bridge 25 to rotate through a desired angle. If, for example, it is desired that this angle be 1°, simple geometry gives that the distance R must be $180/\pi = 57{,}30$ mm. Turning knob 35 one revolution will thus cause bridge 25 to rotate 1° = 60 minutes. Thus knob 35 can suitably be graduated in minutes, as indicated in Fig 6, However, for the purpose of the invention the graduation is made in a disc 36, adjustable in relation to knob 35, which disc follows the movement of knob 35 through a simple frictional coupling device but can be readily reset in relation to the knob while overcoming the friction between knob and disc.

As explained in the foregoing the camber angle α could be determined by measuring the angle through which bridge 25 has to be rotated, with measuring prism 20 placed on pin 10, in order to assume the same true horizontal position as when placed on rod 15. In accordance with the above the change of angle can be observed directly on disc 36 of knob 35 by the disc being zeroed at the operations on rod 15; in the final operations on pin 10 the angular change = the camber angle can thus be read directly on the scale of disc 36. It is pointed out that in practice it is desired that the camber angle be accurately determined, and as shown above the measuring prism according to the invention will give the camber angle by an accuracy of minutes.

What characterizes the invention is the swiftness and surprising accuracy by which the camber angle of wheels and axles of a motor vehicle can be determined by the light and unbulky instruments described. These instruments, thus measuring prism 20 and bar 15 with V-blocks 14, can be used substantially anywhere with no particular demands being made on the premises. However, it is pointed out that the technical devices here described can be modified and varied in many ways within the scope of the invention, and this is thus not limited to the embodiments shown and described.

Claims

1. A method for measuring the wheel inclination or "camber" (a) of a vehicle without demounting the wheels of the set of wheels subject to measurement and without requirement for special or "levelled" sites for carrying out measuring, said measuring being prepared, with the wheels resting on a substantially plane floor or base (H) with their centers on the same level above said base, by a first of the wheels subject to measuring being provided, in a way known per se, with an axial extension on one side in the form of a cylindrical pin (10) which is secured to the wheel with its axis parallel with or coinciding with the rotational axis (x-x) of the wheel, **characterized in that** a straight reference member (15) in the form of a rod, bar or the like, whose one end at least constitutes a coaxial, cylindrical reference pin (15) rather like the said wheel pin (10), is placed on the base (H) in front of and close to the wheels of the wheel set with said reference pin parallel with the base (H) and approximately parallel with a line between the wheel centers, preferably carried, at points approximately equilocated, in two alike support members, e.g. so called V-blocks; and **in that** the difference between the inclination to the true horizontal plane of the reference pin (15) and the inclination to said true plane of the wheel pin (10) is measured by means of an instrument (20) sensing and indicating the direction of the gravity force, said difference being, according to definition, the value of the wheel inclination or camber (α) sought.

2. A method according to claim 1, **characterized in that** a measuring body (20) in-

cluding the said gravity sensing and indicating instrument is placed on a selected one of the pins, for example, the reference pin (15) which, like the wheel pin (10), fits slidably in a guide groove (42) formed in the underside of the measuring body, said body having a pivotable and the direction of gravity sensing and indicating member (24, 25, 26) with its pivot axis (y-y) directed perpendicularly to said guide groove (42) and thus to the reference pin (15) and the wheel pin (10), respectivly;
in that, on the one hand, the measuring body (20) is turned on the reference pin (15) and, on the other hand, the gravity sensing member (24, 25, 26) is pivoted on the measuring body until a position is reached wherein the member indicates that it is situated in the true horizontal plane; **in that** the measuring body (20) is moved to the other one of the pins, thus the wheel pin (10), and the above procedure is repeated: the measurring body (20) is turned on the wheel pin and the gravity sensing member (24, 25, 26) is pivoted on the measuring body until the member indicates again that it lies in the true horizontal plane; and
in that the angle which the said member has to be pivoted about its axis (y-y) in order to restore its true horizontal position is recorded, as this angle is the camber angle (α) sought.

3. An apparatus for carrying out the method according to any of the preceeding claims for measuring the wheel inclination or "camber (α) of a vehicle by providing a wheel of a wheel set subject to measurement with a concentric axle pin (10), placing a straight reference member (15) in the front of the wheel set and carrying out the measurements by means of a measuring body (20) including an instrument sensing the direction of gravity,
characterized in that the measuring body includes a platelike bridge (25) pivotably carried on the body with its pivot axis (y-y) directed perpendicularly to a guide grove provided in the underside of the measuring body, preferably in the form of a V-groove (42), the bridge being pivotable by means of a screw spindle mechanism (30-36) operated by a knob adapted to show on a graduation the angle of the change in inclination of the bridge, the angular position of the bridge being indicated by two levels (24, 26) situated on the bridge, whereof one level (24) is directed parallel with the pivot axis (y-y) of bridge whereas the other level (26) is directed perpendicularly to the first level (24).

4. An apparatus according to claim 3,
characterized in that the measuring body (20) includes a U-shaped framework (28) wherein said bridge (25) is pivotably carried actuated by a spring (34) in one pivot direction, the said screw spindle mechanism including a screw spindle (30) secured in the framework and extending, substantially perpendicularly to the bridge (25), through an opening in said bridge in order to engage a knob wheel (35) which limits, by engaging the topside of the bridge, the spring-actuated movement of the bridge.

5. An apparatus according to claim 4,
characterized in that a spacing member (32) having a straight edge (32) is inserted between the topside of the bridge (25) and the underside of the wheel knob (35), the spacing member being slideable against the underside of the knob wheel (35) but engaging by its edge (32) in a notch (25') in the bridge, which notch is parallel with the pivot axis (y-y) of the bridge and extends perpendicularly to the axis of the screw spindle (30) and is designed such that it allows the spacing member (32) to tilt during the adjustment movements of the bridge.

6. An apparatus according to claim 5,
characterized in that the screw spindle mechanism is specifically adjusted in relation to the pivot movement of the bridge (25), e. g. such that the screw thread pitch is 1 mm and the perpendicular distance between the spindle axis and the pivot axis (y-y) of the bridge is $180/\pi = 57{,}30$ mm, which means that turning the knob wheel (35) one revolution will cause the bridge (25) to pivot 1°, the said graduation being provided on a disc (36) mounted concentrically on the knob wheel (35), said disc being adjustable on the knob wheel e.g. under friction in order to indicate, from a starting or zero position, a change in the inclination of the bridge.

7. An apparatus according to any of claims 4-6,
characterized in that the said V-groove is provided in a magnetic locking body secured on the underside of said framework (28), said locking body being arranged in such a way that its magnetic locking effect can be switched on and off by means of a handle (45).

8. An apparatus according to any of claims 4-7,
characterized in that the reference member (15) consists of of a simple, straight tube (15).

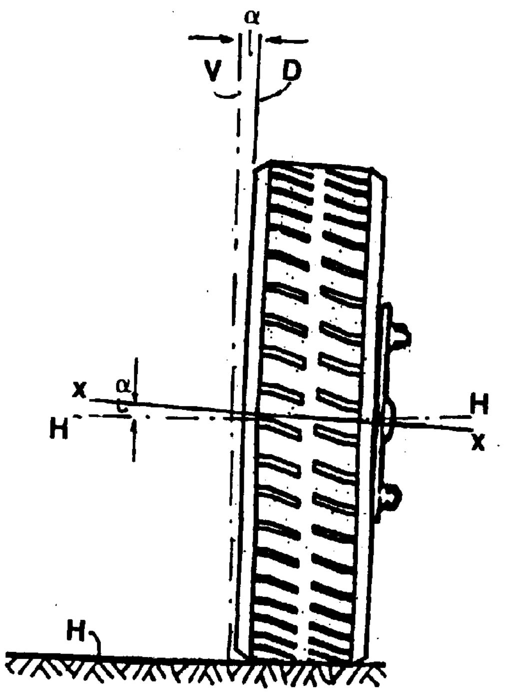


Fig. 1

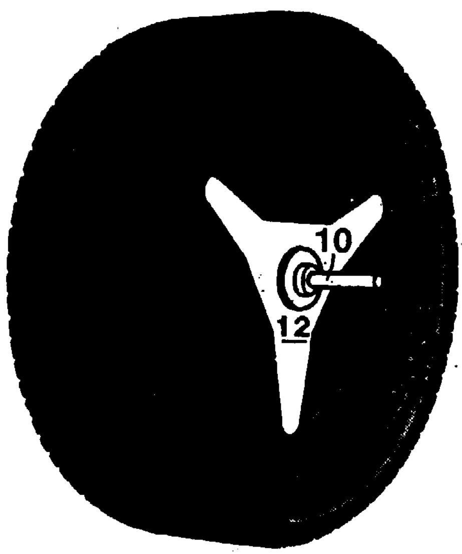


Fig. 2

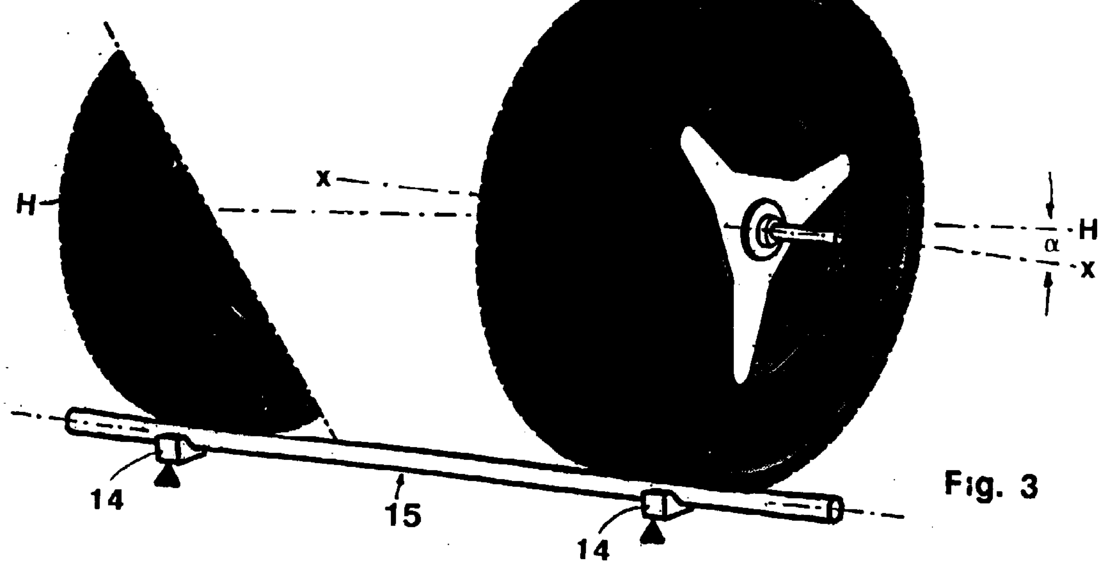
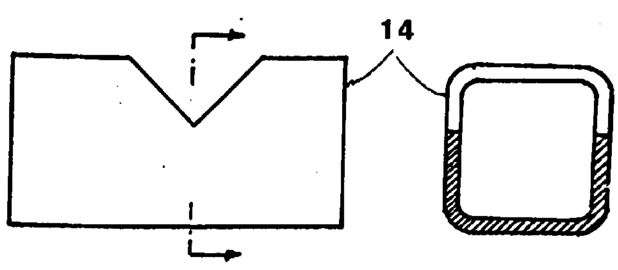


Fig. 3

Fig. 4



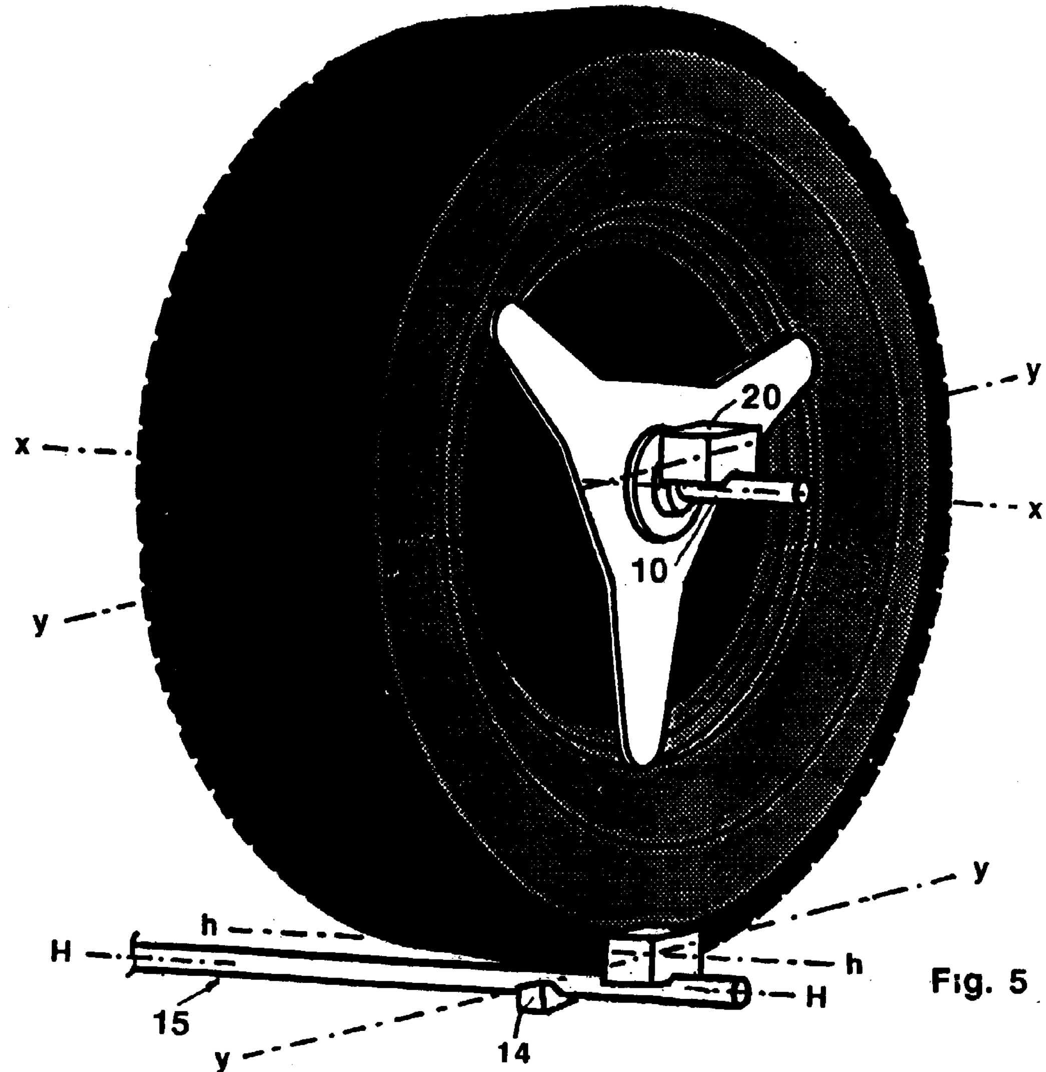


Fig. 5

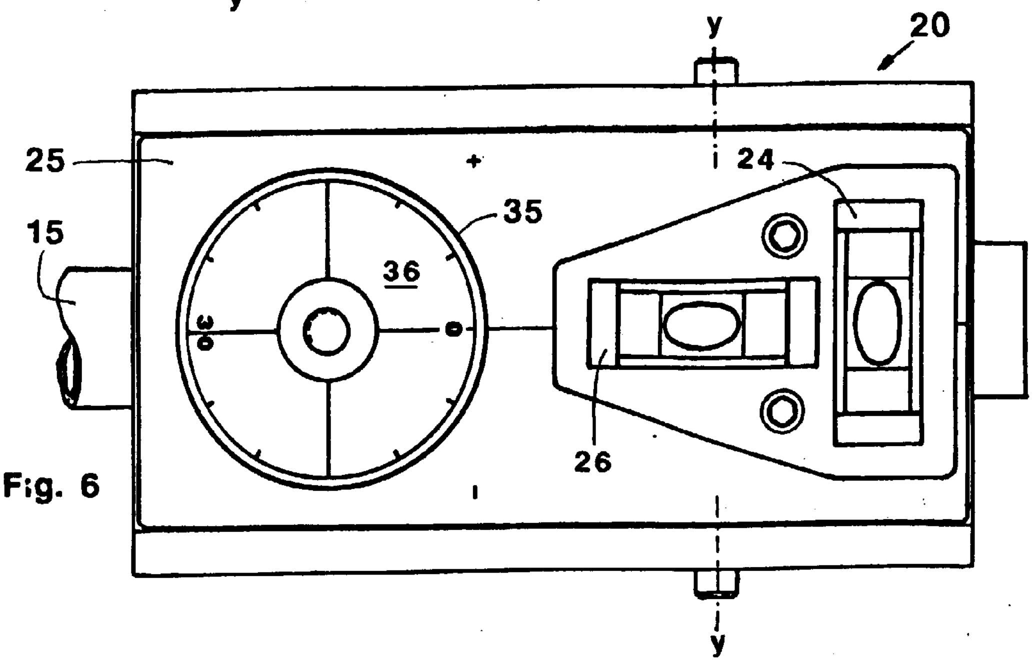


Fig. 6

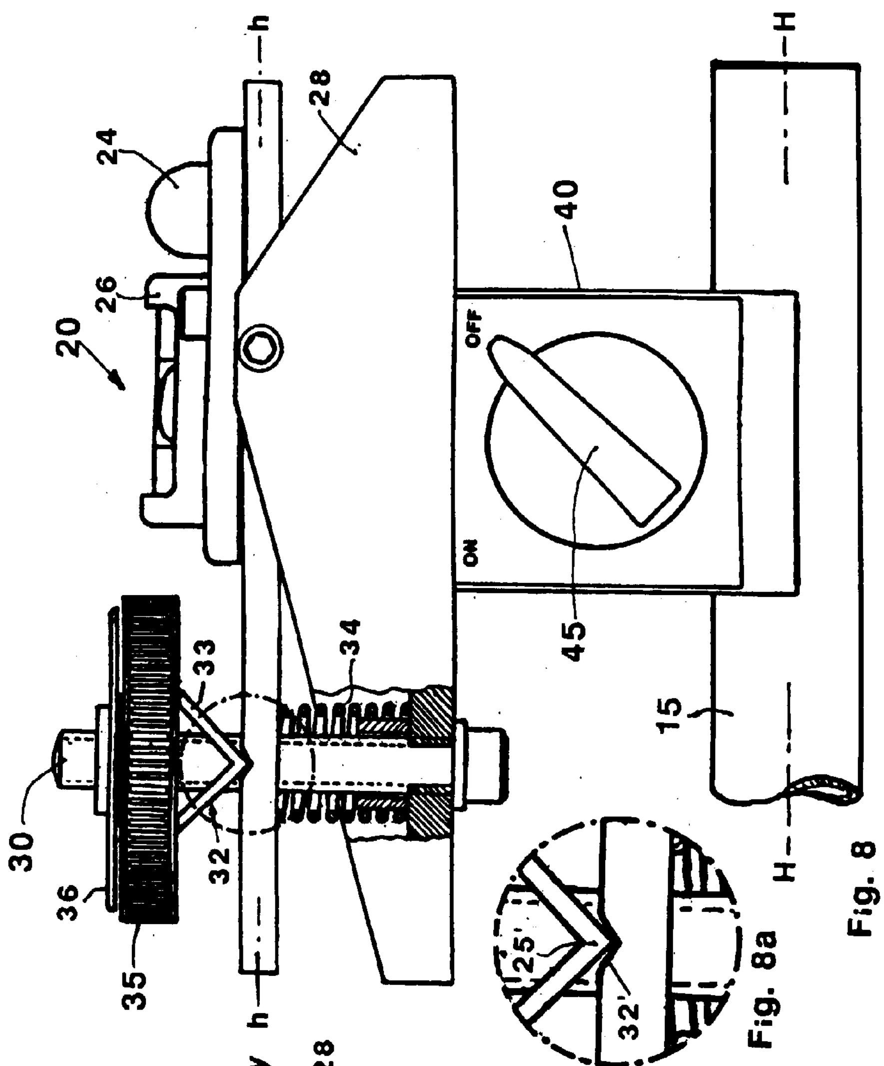


Fig. 8a

Fig. 8

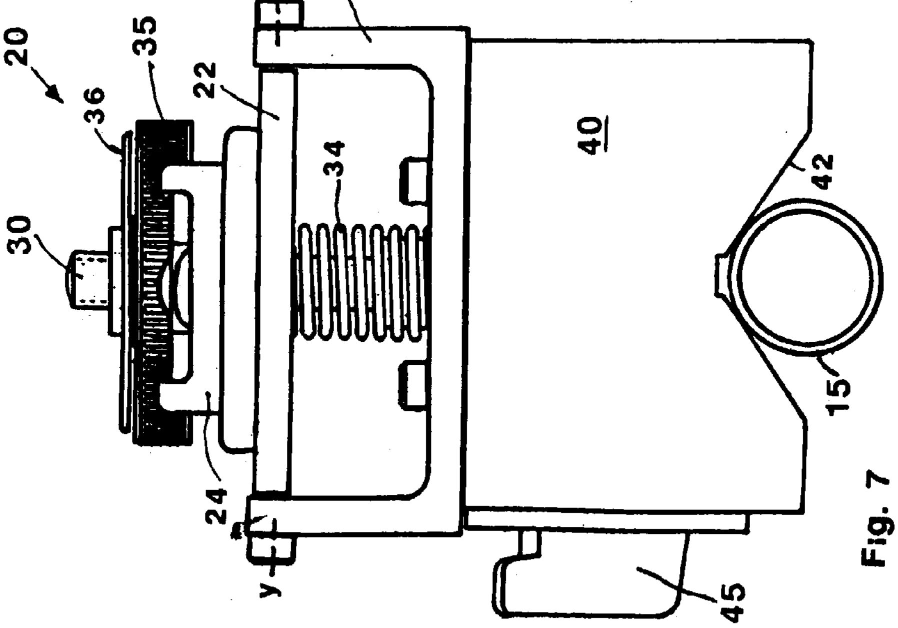


Fig. 7